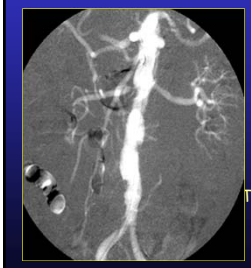
- *The views presented reflect those of the author/presenter and do not necessarily reflect those of ASDIN nor serve as an endorsement of safety, efficacy or applicability of said procedure.*

Use of CO_2 and Other Contrast Agents in Endovascular Procedures



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Interventional Radiology
University of Michigan

The ASDIN 9th Annual Scientific Meeting
February 15-17, 2013
Washington, DC

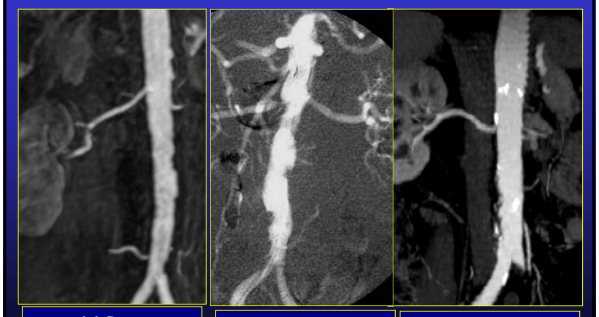
Disclosure

None

Outline

- CO_2 Angiography
- Gadolinium Angiography
- Saving Iodinated contrast

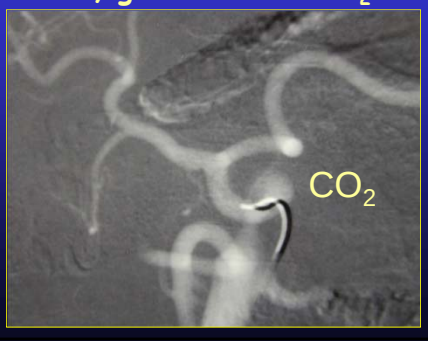
Which is which?



MRA | CO_2 | CTA

Which contrast agent?

Iodine, gadolinium or CO_2



Which contrast agent?

Iodine, gadolinium or CO_2

CO_2 IS THE ONLY PROVEN "SAFE" CONTRAST FOR ALLERGY AND/OR RENAL FAILURE

CO_2 for Diagnosis and Intervention in the arterial circulation

"EXCEPT"

Thoracic aorta, Coronary and cerebral circulations

CO_2 for Diagnosis and Intervention in the venous circulation

20 SWINE

CO_2 IV

.2cc - 6.4 cc/kg

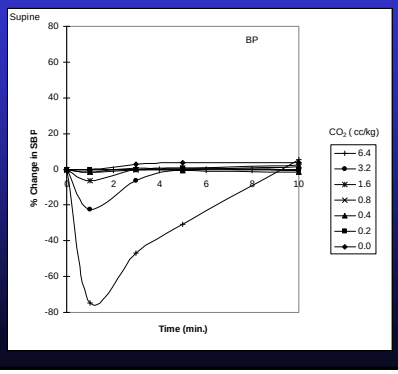
EXTENSIVE MONITORING

PA PRESSURE

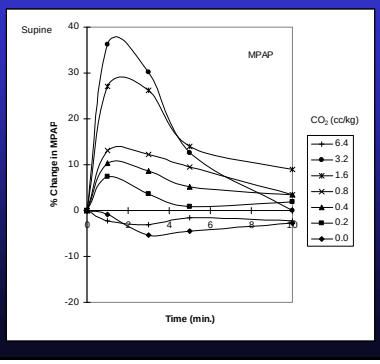
Blood gases

- 60cc: no change
- 60 cc: ↑ PA pressure
- 600cc: 1 death

BP response to intracaval CO_2



PA pressure response to CO_2



CO_2 Cylinder

CARBON DIOXIDE USP

99.9% Pure CO_2

Delivery of CO_2

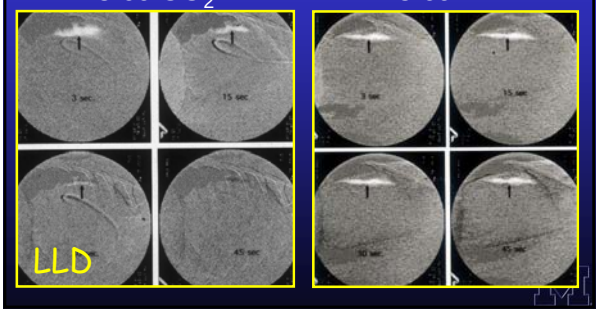
- Hand-held Syringe
- Plastic bag
- CO_2mmander w/AngiAssist
- CO_2 injector

Properties of CO_2

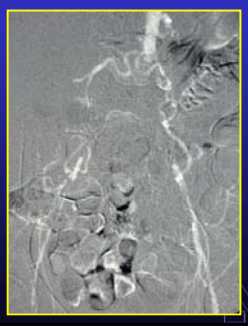
- High solubility
- Low viscosity
- Buoyancy
- Compressibility

CO_2 is 20 times more soluble than oxygen

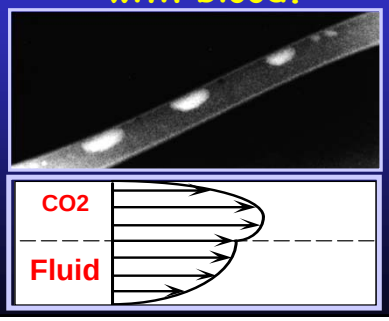
5 cc CO_2 5 cc Air



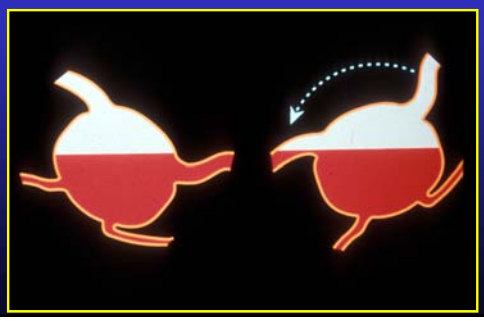
CO_2 is 400 times less viscous than iodinated contrast



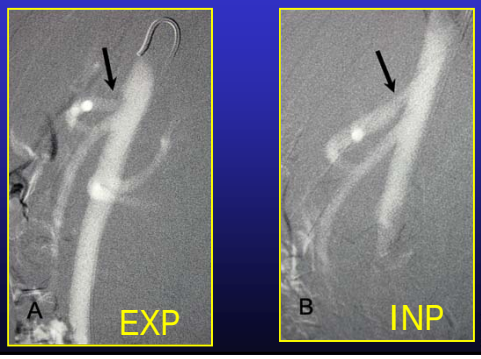
CO_2 is extremely buoyant and displaces rather than mixes with blood.



CO_2 in the aorta floats, filling the celiac and SMA.

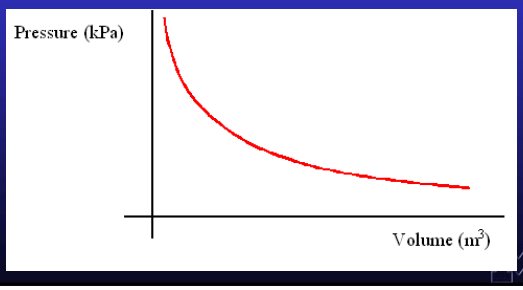


30 CC CO_2 X-TABLE LAT



20 cc CO_2 L Side UP

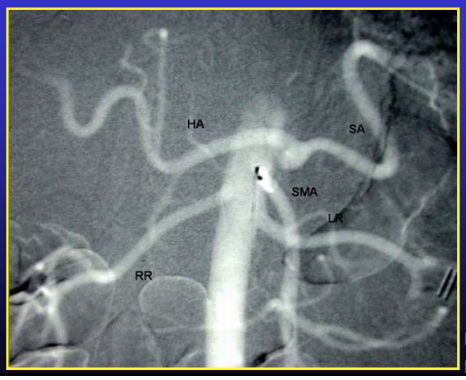
According to Boyle's Law, CO_2 will be compressed in the catheter during the injection



CO_2 Reflux

Buoyant and compressed CO_2 injected between wire and catheter refluxes into the aorta

CO_2 Reflux



CO_2 Reflux

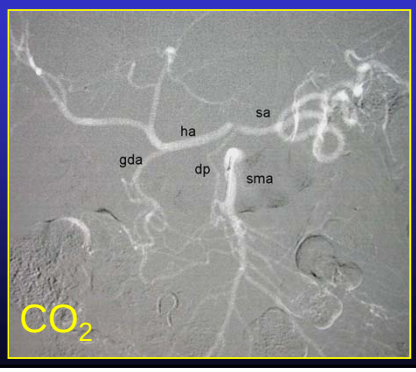
20 cc CO_2 Antegrade Inj. in SFA

Applications of CO_2 Angiography

Arterial Applications

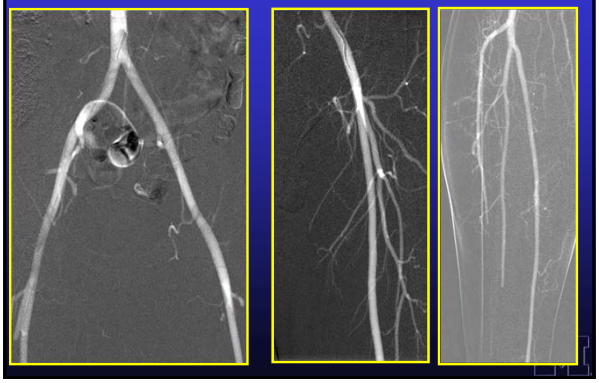
- A & O
- Renal artery
- Mesenteric artery
- Renal transplant
- Detection of bleeding
- Tumors
- Aneurysm, AVM, AVF
- Interventions

Celiac Axis Occlusion

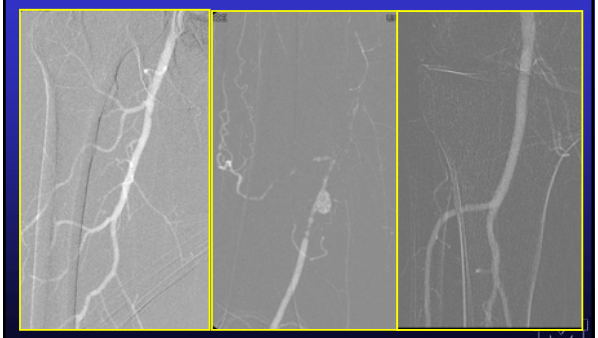


Renal transplant

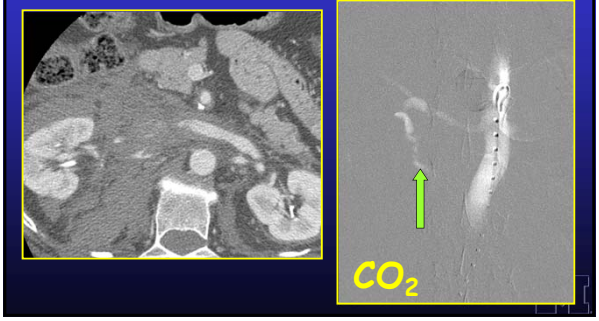
CO_2 A & O



Occlusion of SFA

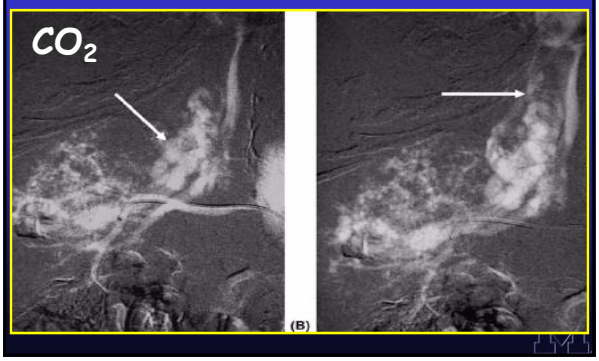


EDS 1V
Renal Artery Rupture

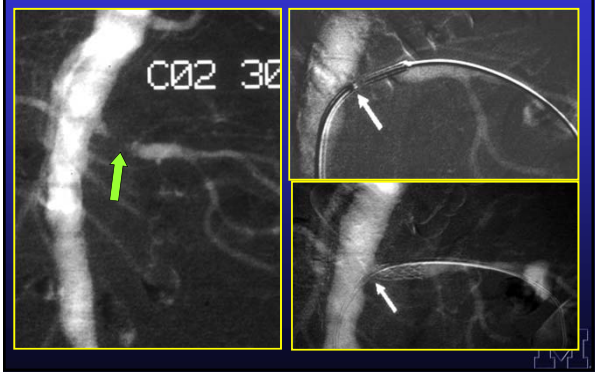


Coil Embolization

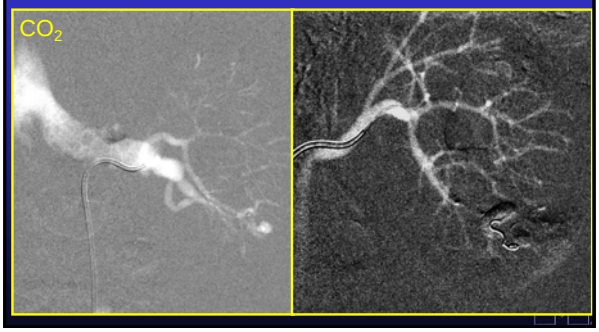
Renal Cell Carcinoma



CO_2-guided Renal Stenting



Post Renal Biopsy Hematuria



Common Iliac Artery Aneurysm

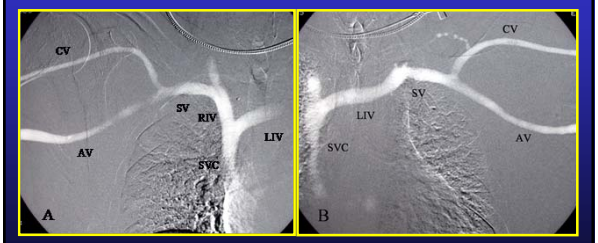
Venous Applications of CO_2 Angiography

Indications

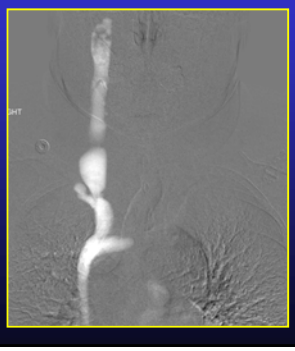
- Opacify central veins
- PTA and stent placement
- IVC filter placement
- TIPS
- Transjugular liver biopsy
- Splenoportography
- Portal vein access

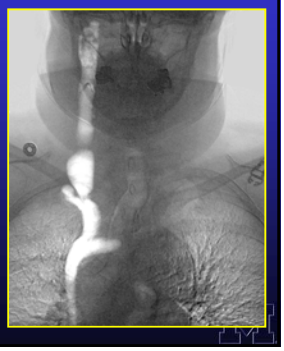
Upper Limb Venograms

CO_2 Central Venograms

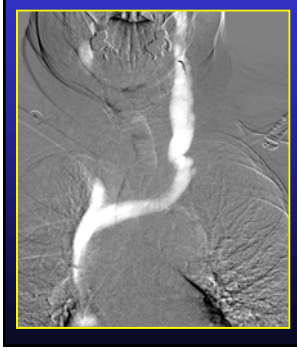


CO_2 Jugular Venogram

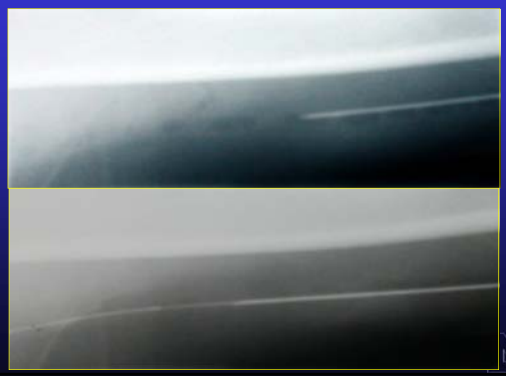




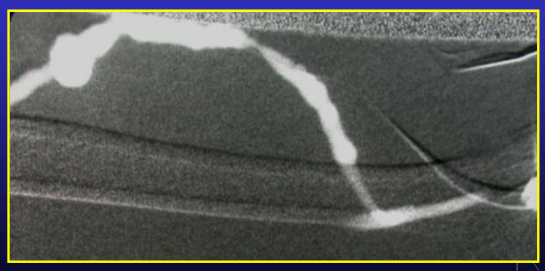
CO_2 Jugular Venogram



CO_2 for PICC

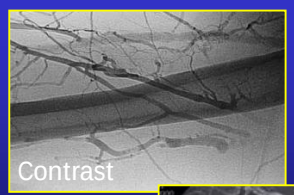


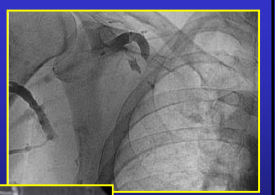
CO_2 fistulogram



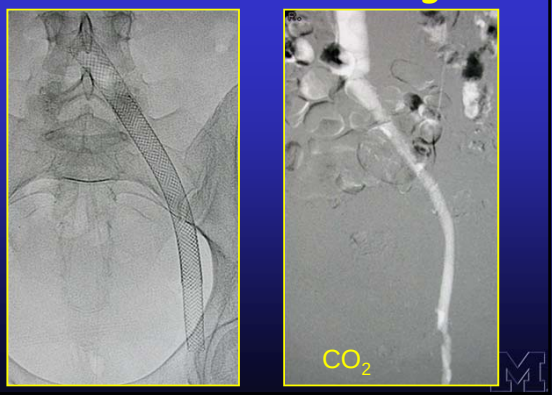
Occlusion of left subclavian vein

Axillosubclavian Vein Thrombosis

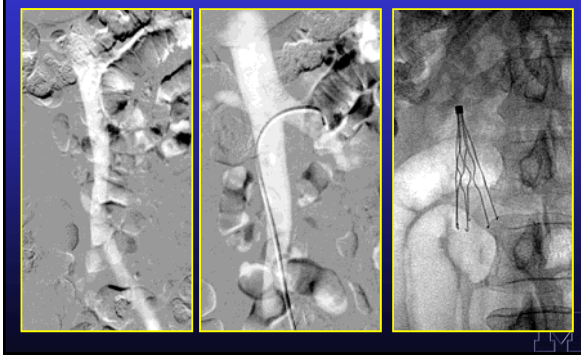




L iliac Vein Stenting



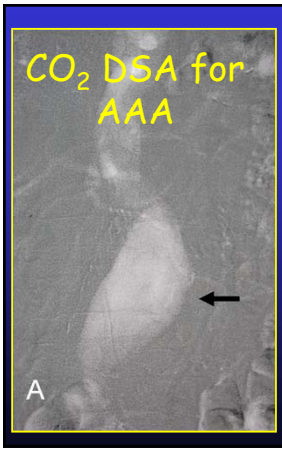
CO_2 Filter Placement

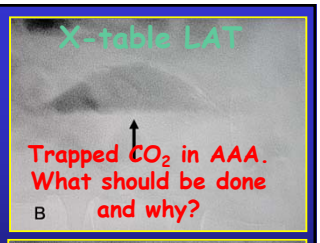


Potential Complications of CO_2 Angiography

- Air contamination
- Vapor lock:
  - Pulmonary artery (hypotension)
  - Mesenteric artery (Intestinal ischemia)
  - Simultaneous nitrous oxide anesthesia
- Neurotoxicity (CO_2 injection in carotid artery)
- Paradoxical embolism
- Hepatic capsule laceration (CO_2 wedge injection)

CO_2 DSA for AAA





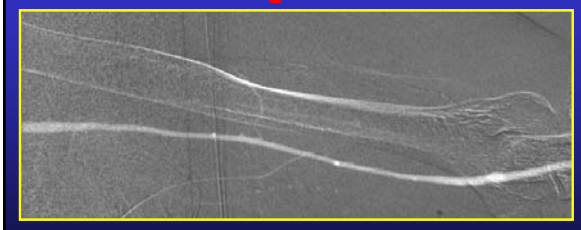
CO_2 guided Vascular Mapping for Hemodialysis Access Surgery in a Patient with Failing Renal Allograft

Case History

- 51 y/o F w/ PCKD and ESRD
- Failing renal txp
- Failed dialysis fistula, bil UE
- L basilic vein-radial artery fistula
- Request for:
  - L arm venogram
  - L arm arteriogram

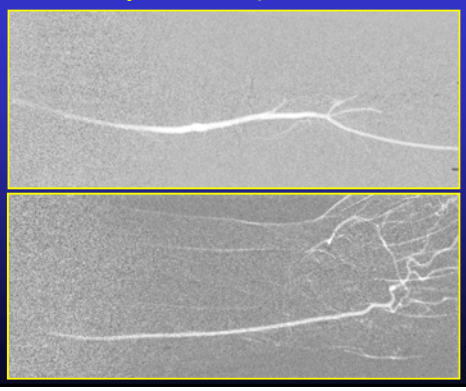
L arm CO_2 venogram

Brachial Artery Puncture for CO_2 DSA



Adverse reaction: lightheaded, bradycardic and hypotensive

L forearm DSA



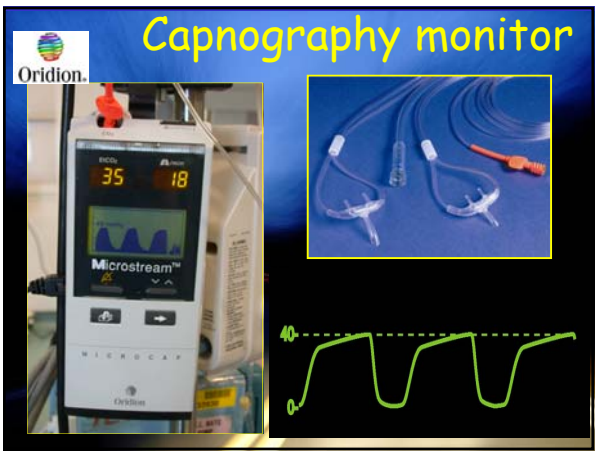
How to make CO_2 angiography work better?

- DSA
- Endhole catheter
- Reflux angiography
- Selective injections
- New mask (move mask)
- Stacking
- Elevate area of interest
- Vasodilators

Monitoring CO_2 Angiography

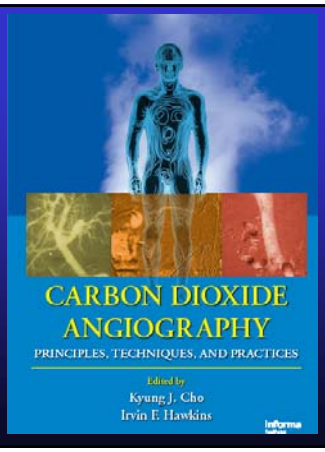
- Oxygenation = Pulse oximetry
- Perfusion = BP, HR, ECG
- Ventilation = Capnography

Capnography monitor



Conclusions

- CO_2 is the only proven safe contrast agent in allergy and renal failure.
- CO_2 should not be used as an arterial contrast agent above the diaphragm.
- Use a closed system for CO_2 delivery to prevent air contamination.
- Do not use with nitrous oxide anesthesia.
- The advantages of CO_2 include use of unlimited total volume and low viscosity for vascular diagnosis and endovascular intervention.



Gadolinium Angiography

Physical Properties of CO_2, Gadolinium and Iodine

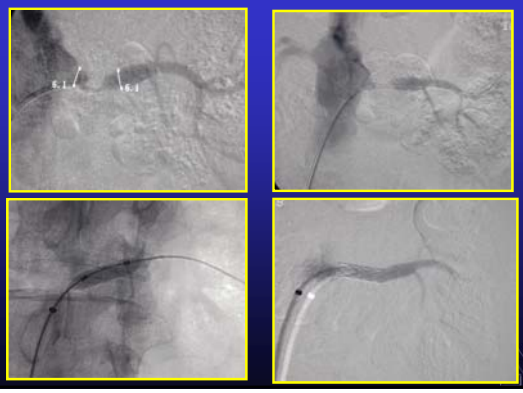
Atomic number

CO_2	C = 6, O =8
Gd	64
Iodine	53

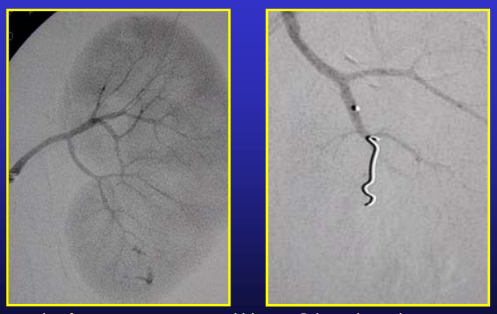
Fewer Gd atoms /cc of contrast: 1/3 attenuation values

Radiopacity Comparison

Gadolinium-assisted Renal Stenting



Gd-guided Renal Embolization



Hematuria after percutaneous renal biopsy. Gd renal arteriogram demonstrates active extravasation in lower pole of left kidney that was embolized with microcoils

Iodinated Contrast Saving Strategies

- CO_2 for arteriography and venography, and endovascular intervention
- Dilute iodinated contrast agent when needed.

Thank you